Weatherwise

Volume 8, Number 3 June 1955

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

The Hurricane Problem

Every American assumes a natural right to complain about the weather. He is also endowed with the freedom of speech to criticize the shortcomings of the Weather Bureau—that is our democratic way. But at the same time these privileges require that those of us who are seriously concerned with the ultimate solution of the weather problem should rally to the support of the national weather service when it is in need.

The present appears to be a turning point in the development of the Weather Bureau. Now it has friendly critics on Capitol Hill. Its operations have been subjected to a searching inquiry by the George Committee. As one result, an additional $5 million has been appropriated for the next four years to modernize the basic observing equipment. Now modern radars will detect storms and electronic calculators will assist forecasters. Another Congressional bill would allot the sum of $5 million to set up an adequate hurricane warning system this year. (See page 77 for status of this bill.)

The attack on the hurricane problem must be threefold: (1) An adequate observation system must be established in all parts of the hurricane area and continued without interruption; (2) a basic research program must be instituted that will probe the physical nature of the hurricane both through observation and theory; and (3) the public must be educated so as to respect these storms and to heed warnings—only then will the fruits of research have practical value.

The hurricane problem, like all other meteorological problems, is not a matter of the current season only. It will require many men working over many years to bring about an adequate understanding of the hurricane. But it appears that the means of solving this problem are at hand. All that is required are the funds to mobilize the attack and to keep it going over the coming years. The only way to do this appears to be through increased Congressional appropriations earmarked for this purpose. So let us exert our democratic privileges and let our Congressmen and local editors know what weathermen think about this.

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Front Cover: Two unidentified yachtsmen hang desperately to a tree as they watch their yacht smash against the rocks at Wollaston Beach, Quincy Bay, near Boston, on 31 August 1954 during Carol. Wide World Photos.

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H. R. 5260

"The Hurricane Bill"

Representative James T. Patterson, Fifth District, Connecticut, introduced H.R. 5260 in the House of Representatives on 28 March 1955: "A Bill making an appropriation for the operation of an emergency hurricane warning system by the Weather Bureau." A sum of $5 million was requested to carry out the ten-point program listed below. Mr. Patterson stated: "I firmly believe that this added appropriations will enable the Weather Bureau to establish and operate an emergency hurricane warning system which will provide much greater advance warning of approaching storms. A few hours more of advance warning can mean the difference between life and death."

1. To provide staff sufficient to keep Weather Bureau Offices open 24 hours a day in 10 coastal cities from Maine to Texas where existing Weather Bureau Offices are now open only part-time.

2. To provide technically trained staff sufficient to re-open Weather Bureau Offices in 5 coastal cities from Maine to Texas where formerly existing Weather Bureau Offices have been closed.

3. To operate special teletypewriter, facsimile, telephone, and radio networks for the prompt relay of meteorological information used in forecasting hurricanes and major storms, and used for instantaneous distribution of hurricane warnings and alerts to all areas and citizens concerned.

4. To provide staff and observing equipment to operate 12 additional rawinsonde stations in the United States east of the 100th Meridian and in other selected land areas adjoining the Gulf of Mexico, Caribbean Sea and western Atlantic Ocean; and to provide staff and supplies at existing rawinsonde stations to take required upper-air observations at *six-hourly* intervals instead of at *twelve-hourly* intervals during the hurricane season.

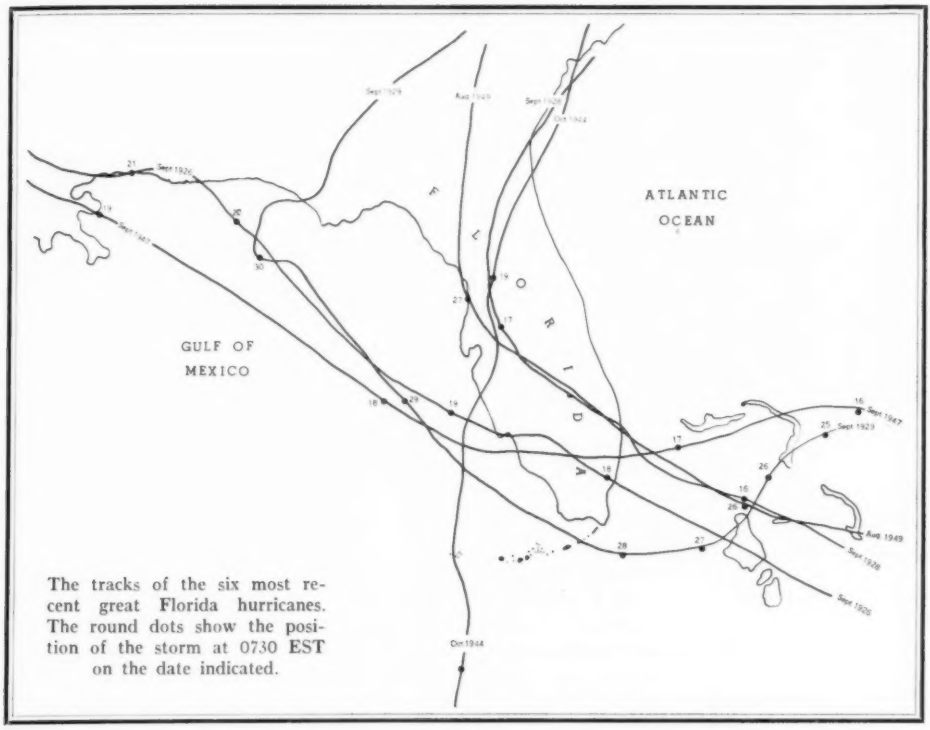
5. To provide additional weather observations during storm periods from merchant ships traversing the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico.

6. To provide additional forecasters, additional meteorological chartmen, and additional communicators to provide around-the-clock hurricane forecasting watches at each of the following six hurricane forecast centers: Boston, New York, Washington, Miami, New Orleans, and San Juan.

7. To establish an improved high water warning service in order to inform coastal areas of approaching high storm tides, damaging waves, and other coastal inundations from abnormal water levels and floods associated with hurricanes and heavy coastal rain storms.

8. To provide meteorological staff and facilities for "Emergency Hurricane Warning Centers" and for "Mobile Storm Warning Squads" to supplement the local Weather Bureau staffs during the intense activity accom-

(Continued on page 82)



The tracks of the six most recent great Florida hurricanes. The round dots show the position of the storm at 0730 EST on the date indicated.

A Comparison of Six Great Florida Hurricanes

DONALD C. BUNTING, *Department of Physical Sciences, University of Florida*

DURING the past 74 years there have been twelve "great" Florida hurricanes. Of these twelve, the six most recent ones are described in this paper. One of these six is probably the "greatest" in the past three-quarters of a century.

The criteria employed by C. L. Mitchell to describe a "great" hurricane are that the central pressure be near or below 28.00 inches, and that the diameter of the path of great damage from the wind measures from 50 to 100 miles or more. Each of these criteria is satisfied in the six storms to be described, although the diameter of the path of great damage is subject to somewhat arbitrary interpretation. In order to be specific and since the damage produced is more the result of what is in the path of the storm rather than the actual strength of the wind in many cases, a sustained wind of over 50 miles per hour is considered in this paper as a dangerous wind and likely to be sufficient to produce great damage. In each of the "great" hurricanes analyzed, the strength of the sustained winds was 50 mph or more in a path diameter of 50 to 100 miles or more.

SIX "GREAT" FLORIDA HURRICANES

1. Miami Hurricane, 18 September 1926
2. Palm Beach Hurricane, 16 September 1928
3. Long Key Hurricane, 28 September 1929

4. Dry Tortugas Hurricane, 18 October 1944
5. Fort Lauderdale Hurricane, 17 September 1947
6. Delray Beach Hurricane, 26 August 1949

Origins

It has been fairly well established that four and possibly five of these six storms originated in the vicinity of the Cape Verde Islands, a favorite breeding place for the really great hurricanes of midseason. In traveling across such a large expanse of water, these Cape Verde storms often reach full maturity and violence before they cross over the West Indies or reach the United States mainland. The so-called Cape Verde hurricanes were those of 1926, 1928, 1929, and 1947. The 1949 storm, although first reported about 125 miles northeast of St. Martin, most likely originated as an easterly wave from the Cape Verde area. Five of the six storms thus originated south of 20° N latitude and east of 60° W longitude. The one exception was the Dry Tortugas hurricane of 1944, which originated in the western Caribbean.

Paths

Up until the time of crossing the 70th meridian, five of the six "great" hurricanes had paths which were similar in direction, the storms moving either toward the west-northwest or northwest. The most northerly path was taken by the 1929 storm and the most southerly by that of 1928, which was the "San Felipe" that crossed Puerto Rico. The 1926, 1947, and 1949 hurricanes had paths roughly midway between the two outermost ones.

After crossing the 70th meridian, two storm paths continued onward in about the same direction to the Florida coastline, namely the Miami and the Palm Beach hurricanes. Two other storms, the Fort Lauderdale and Long Key hurricanes, recurved toward the south-southwest or southwest while crossing the Bahama Islands; while the fifth storm, the Delray Beach hurricane, recurved from the northwest to the west-northwest shortly after crossing the 70th meridian.

After striking the Florida coast, the storms of 1949 and 1928 eventually recurved toward the north either along the Florida west coast or in central peninsular Florida, crossing into southeastern Georgia. The other three storms continued across the southern part of the state and moved out into the Gulf of Mexico. The 1929 hurricane moved erratically in the eastern Gulf and finally re-entered the state just southeast of Panama City after making a small horseshoe loop to the southwest of Appalachicola. The 1926 hurricane center approached very close to Pensacola but actually did not cross the Florida coastline again. The 1947 storm moved northwesterly across the eastern Gulf and finally moved onto the coast again in Louisiana, passing directly over New Orleans.

Only one of these "great" hurricanes moved in from the western Caribbean and eastern Gulf of Mexico; the 1944 storm traveled in a north or north-northeasterly direction and first crossed the Florida coastline in the vicinity of Fernandina Beach. Thus, four of the hurricane centers actually crossed over the extreme northern part of Florida, and one other greatly affected the northwestern sector while in the Gulf of Mexico.

Average Rate of Movement (MPH)

Storm	Just prior to reaching Florida	While over Florida
1926	18–20	12–15
1928	14.5	12–15
1929	3	8
1944	18–30	19
1947	8	10
1949	18–20	10

Of the five storms striking Florida from the east or southeast, two showed erratic speeds prior to reaching the coast due to recurvature toward the south, which slowed them down for 24 hours or more. The 1929 storm traveled at a speed of less than 4 mph for 3½ days while over the Bahamas; and the 1947 disturbance remained nearly stationary for almost 24 hours in the vicinity of Abaco Island, Bahamas.

Two others, the Miami and Delray Beach hurricanes, showed above average speeds of 18 to 20 mph before arriving at the Florida coast, while the Palm Beach storm progressed at a regular rate of about 14.5 mph the

A view of the rubble on the main street of West Palm Beach, Florida, after the hurricane of 16 September 1928. Tattered palm trees may be seen in the background. Wide World Photos.

whole distance from Puerto Rico to the Florida coast.

The 1944 storm, which moved over the state from the south, showed erratically slow movement while south of Cuba, but then moved at a greater than normal speed of about 18 to 20 mph as it crossed over the west coast of Florida.

A computation of the average speeds has been made for each of the six storms while over the Florida mainland. The fastest moving hurricane was that of 1944, which traveled from south of Sarasota to Jacksonville at an average speed of about 19 mph. The slowest moving hurricane was the erratic Long Key storm which traveled at a speed of about 8 mph from Panama City to the Florida state line. The 1926 and 1928 hurricanes had an average speed while over Florida of 12 to 15 mph, while the 1947 and 1949 hurricanes averaged only about 10 mph. The relatively slow average movement of the 1949 storm was due to its recurving while over the state.

PATH DISTANCE OF CENTERS AND TIME OVER FLORIDA

Storm	Miles	Hours and minutes
Delray Beach, 1949	360	36:45
Palm Beach, 1928	344	27:30
Dry Tortugas, 1944	248	13:15
Miami, 1926	144	9:50
Fort Lauderdale, 1947	108	10:30
Long Key, 1929	80	10:00

Up until 1935 the West Palm Beach pressure in 1928 of 27.43 inches was the lowest reported in a hurricane in the United States. This record low pressure was broken by the

LOWEST PRESSURE OVER FLORIDA

Inches	Place	Time	Date
27.43	West Palm Beach	1900	16 September 1928
27.61	Miami	0645	18 September 1926
27.97	Hillsboro Light	1125	17 September 1947
28.02	Dry Tortugas	1700	18 October 1944
28.17	West Palm Beach	0726	26 August 1949
28.18	Long Key	0930	28 September 1929

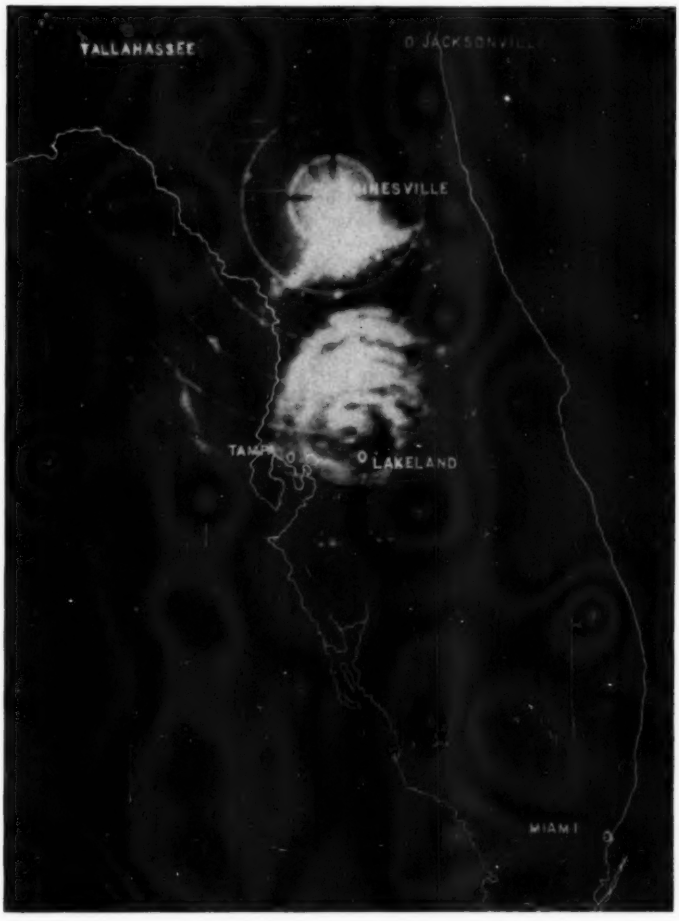
MAXIMUM HURRICANE WINDS

Gusts (mph)	1-minute	5-minute	Place	Date
132		123	Miami Beach	18 September 1926
152		116	Pensacola	20 September 1926
150 (est.)			Canal Point	16 September 1928
150 (est.)			Key Largo	28 September 1929
120 +	120 +	120	Dry Tortugas	18 October 1944
	155	121	Hillsboro Light	17 September 1947
127			Ft. Lauderdale	17 September 1947
	153	132	Jupiter Light	26 August 1949

small but deadly Labor Day 1935 hurricane in the Keys where the pressure dropped to 26.35 inches.

The highest 1-minute maximum wind speed was 155 mph in the Fort Lauderdale hurricane at Hillsboro Light, closely followed by a 1-minute blast of 153 mph at Jupiter Light in the Delray Beach storm. The highest 5-minute maximum wind speed of 132 mph was

(*Continued on page 78*)



The hurricane of 27 August 1949 appears on a University of Florida radar scope at 0615 EST. The center is just north of Lakeland. Ground clutter accounts for the bright image near Gainesville. Range markers are at 20-mile intervals. Phot by the Engineering and Industrial Experiment Station.

Ice crystals generated by dropping grains of dry ice into the cold chamber. Photo by the author.

Simple Experiments in Atmospheric Physics—2

Nuclei, Water Drops, and Ice Crystals

VINCENT J. SCHAEFER,
Director of Research,
The Munitalp Foundation, Inc.

THERE are many interesting and important experiments in atmospheric physics that may be performed with the cold box which was described in the April *Weatherwise*.

Let us first consider the nature of the very air that we breathe and that is also found both inside and outside the cold box.

First of all, air contains about 21% oxygen, 78% nitrogen, while the remaining 1% is composed of argon, carbon dioxide, neon, helium, and krypton, with tiny quantities of many other gaseous materials. This air also holds a certain amount of water vapor as well as tiny floating microscopic and submicroscopic particles. A sunbeam passing through a tiny hole in a darkened room or a strong flashlight beam directed outdoors at night discloses these particles.

THE AEROSOLS OF THE AIR

While some of these particles are fairly large, especially those made up of dust fibers and other light objects, the majority are fairly compact solids or tiny liquid droplets. They come from many places ranging from volcanoes, forest fires, sea spray, and desert dust storms to industrial chimneys, burning trash, coal, gas, or oil residues, and gases from chemical reactions. These tiny floating particles are called nuclei. It is upon such particles that water, ice crystals, and smog particles form. Depending on their composition and size, these nuclei have varying degrees of "activity."

CONDENSATION NUCLEI

A drop of salt spray is carried into the air by a wind at sea and upon drying becomes a tiny cube of salt about 10 microns thick (0.0004″). This forms an excellent means for water drop formation and is called a condensation nucleus. Such particles are always present in atmosphere, but the effective ones may vary in number from as low as ten to several thousand per cubic centimeter (a cube about $\frac{3}{8}$″ on a side). The lowest values occur, as might be expected, in regions where the air is very clean and atmospheric visibility is limited only by the curvature of the earth. The highest values tend to occur over the continents and especially in places where air pollution is greatest. It should be pointed out that, in addition to the active or effective condensation nuclei, there are many thousands of smaller ones in each cubic centimeter of ordinary air. Many of the smaller ones may consist of hydrocarbons or other chemicals that are not "water-like" in their

nature. Some of these will not act as centers for the deposition of water molecules, but serve to gather other chemicals of oil-like (oleophilic) types.

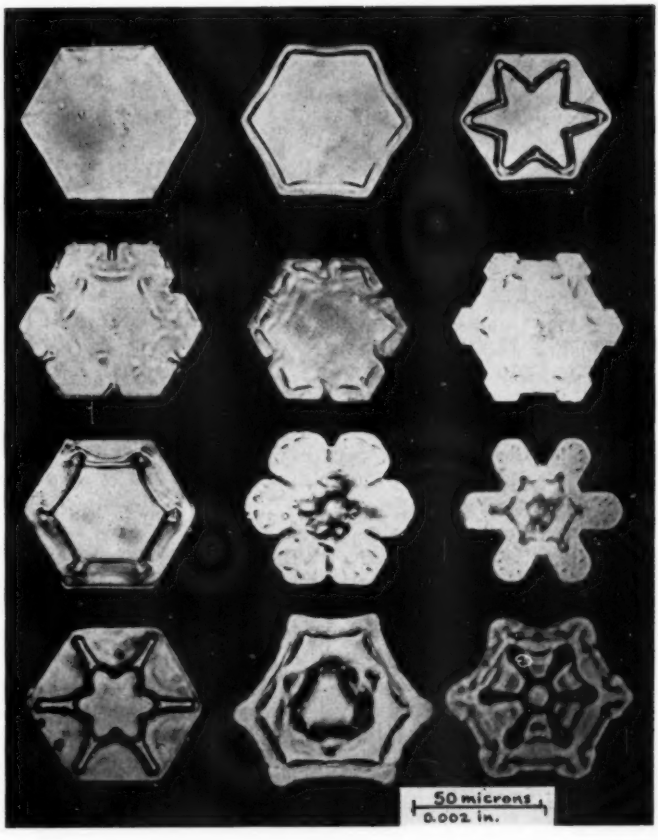
Ice Nuclei

Entirely different types of particles are represented by ice nuclei. These have a very special structure. While some may also serve as active condensation nuclei, they are unique in their action at temperatures colder than 0° C. Most become active as ice nuclei in the temperature range of − 12° C to − 25° C. Some serve as freezing nuclei, others as sublimation nuclei, while a few act as either, depending upon the condition of the atmosphere.

These remarks about nuclei do not exhaust the subject, but are enough to make it easier to understand some of the things we shall do with the cold chamber.

The Formation of a Cloud

Let us assume now that we have a cold chamber lined with black velvet, but which has not yet been cooled to − 20° C. The chamber is illuminated with a light that sends a parallel beam diagonally down into the chamber. Turning on the light, we may see a few dust particles floating in the air. If we breathe into the chamber, nothing happens except that perhaps a few more dust particles appear briefly in the light beam. We then start to cool the chamber, and from time to time try to form a cloud by introducing moist air into the chamber. A damp cloth waved in the chamber may be substituted for the breath as a source of moisture. If a ther-



An interesting variety of snow crystals formed in the cold chamber by dry ice seeding. Photo by the author.

mometer is available, it will be interesting to watch the temperature decrease during this experiment.

The Dew Point

As the cold box gradually becomes colder, it will suddenly reach a temperature at which a cloud will form and remain as visible particles. The temperature at which the cloud forms is called the dew point and is the temperature at which the moisture, provided by our breath or the damp cloth, supplies a sufficient number of water molecules to the cold air in the chamber; the air not only becomes saturated with water molecules but actually receives more than it can absorb in gaseous form. The amount of water which air can absorb varies with temperature—the colder the air the less water will be held in gaseous or molecular form. Thus a cubic meter of air (a little more than a cubic yard of air) at − 20° C (− 4° F) holds 0.89 g, at 0° C (32° F) 4.8 g; at 20° C (68° F) 17.1 g and at 40° C (104° F) it holds more than 50 grams (nearly 2 ounces). In familiar terms the − 4° F sample contains less than a fifth of a teaspoonful of water, while at + 104° F it can absorb 10 full teaspoonfuls—an amount fifty times greater. Is it any wonder we could not form a cloud in the cold chamber when it was at room temperature?

The instant that air at a certain temperature reaches the condition where it is saturated with water vapor, all additional moisture received immediately condenses on the tiny floating nuclei in the air that until then were practically invisible. If these were not present, supersaturation would occur. This rarely, if ever, happens with respect to liquid water in ordinary air, but may be demonstrated in a special type of chamber we will study at a later time.

Under ordinary atmospheric conditions there will be from 100 to 1,000 active condensation nuclei in each cubic centimeter of air. The cloud droplets, which form on such nuclei, grow quickly to a diameter in the range of 10–15 microns or about 0.0005 inch. They look much larger in the light beam as they scatter light so effectively. It would take about 30 placed side by side to equal the diameter of the period at the end of this sentence. If the period were a sphere, it could contain more than 20,000 of these tiny droplets.

Warm, Cool, and Cold Clouds

As the cold box approaches a temperature of 0° C (32° F), we can observe several important relationships by using a piece of dry ice. This effect will be easiest to see if the cold chamber tends to be coldest at the bottom. The first experiment should be carried out when the temperature at the bottom is about + 2° C (35.6° F). A cloud is formed in the chamber; and when turbulence stops, tiny bits of dry ice are dropped into the cloud. Tiny white condensation trails form temporarily in the wake of the falling particles because of their intense coldness. The trails quickly disappear, however, and nothing more may be seen. This is the effect produced in a warm cloud with dry ice.

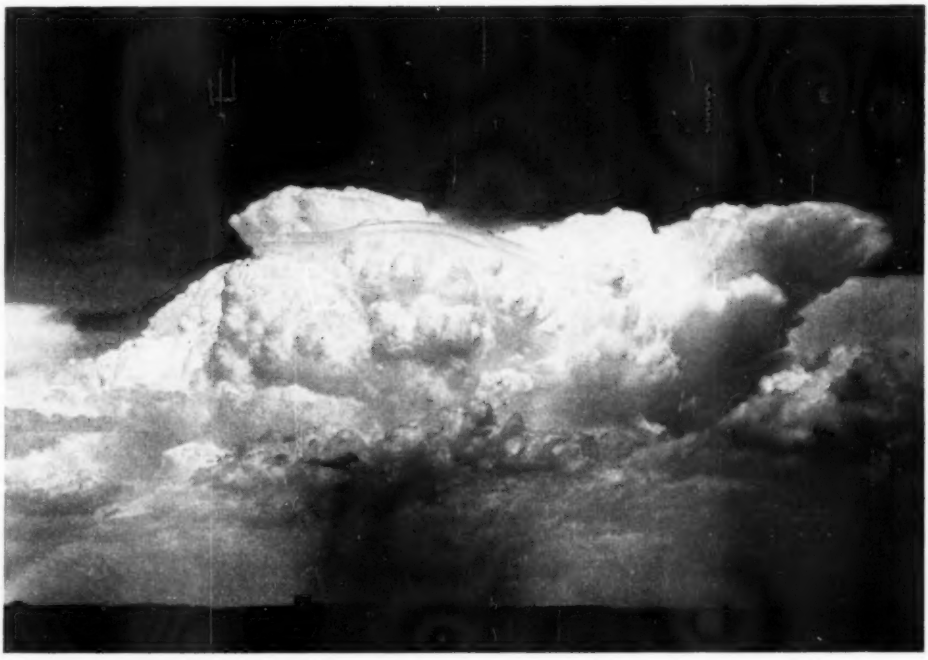
The chamber is then cooled a little more, and a cloud again formed and the turbulence allowed to disappear. If the air in the bottom shows a temperature of − 2° C (28.4° F), the middle 0° C (32° F) and the top + 2° C (35.6° F) bits of dry ice should again be dropped into the quiet cloud. A condensation trail again forms. This time, however, notice that below the 0° C level the trail persists and almost immediately twinkling crystals appear in that region. This was a cool cloud, a term now commonly applied to describe a cloud whose thermal condition includes temperatures both warmer and colder than 0° C.

The final experiment in this series should be made when the cold chamber has reached a temperature colder than 0° C with the bottom showing − 20° C. A cloud is again formed by introducing moisture. Notice first that the cloud appears identical to both the warm and the cool clouds. The light scattered by the cloud droplets appears the same; and in fact, the droplets are still liquid and have the same optical properties of the other clouds. This cloud, however, is unstable. The unstable property can be shown by dropping some tiny grains of dry ice into the quiet cloud. This time the white condensation trails are quickly converted to lines of sparkling ice crystals, which rapidly convert all of the supercooled cloud to ice crystals. When the conversion is complete (10 seconds will suffice with a little stirring), we have an ice crystal cloud instead of a supercooled cloud. This can be demonstrated by scratch-

ing the dry ice so that more particles fall into the chamber. Nothing happens—not even a visible condensation trail as all available moisture has been deposited in the ice crystals. The ice crystal cloud is stable and is made up of crystals like those in the figure.

As more moisture is supplied to the chamber, the crystals grow and then fall to the bottom as in a miniature snowfall. Gradually they fall out until all the crystals are gone and a supercooled cloud again fills the chamber.

Many variations of this experiment are possible. Some will be described in our next chapter.



A "cool cloud" in the atmosphere showing the veil cloud or pileus near the top in the below-freezing section of the cloud. Photo by the author.

OPERATION OVER-SEED

Will over-seeding a cloud actually prevent rather than cause rain? Opinion among cloud-seeders is far from unanimous on this point. Accordingly the President's Advisory Committee on Weather Control has announced that tests will commence this summer at the foot of Mt. Washington with a view of observing the effect on the clouds and precipitation at and near the summit of the 6,288-foot peak.

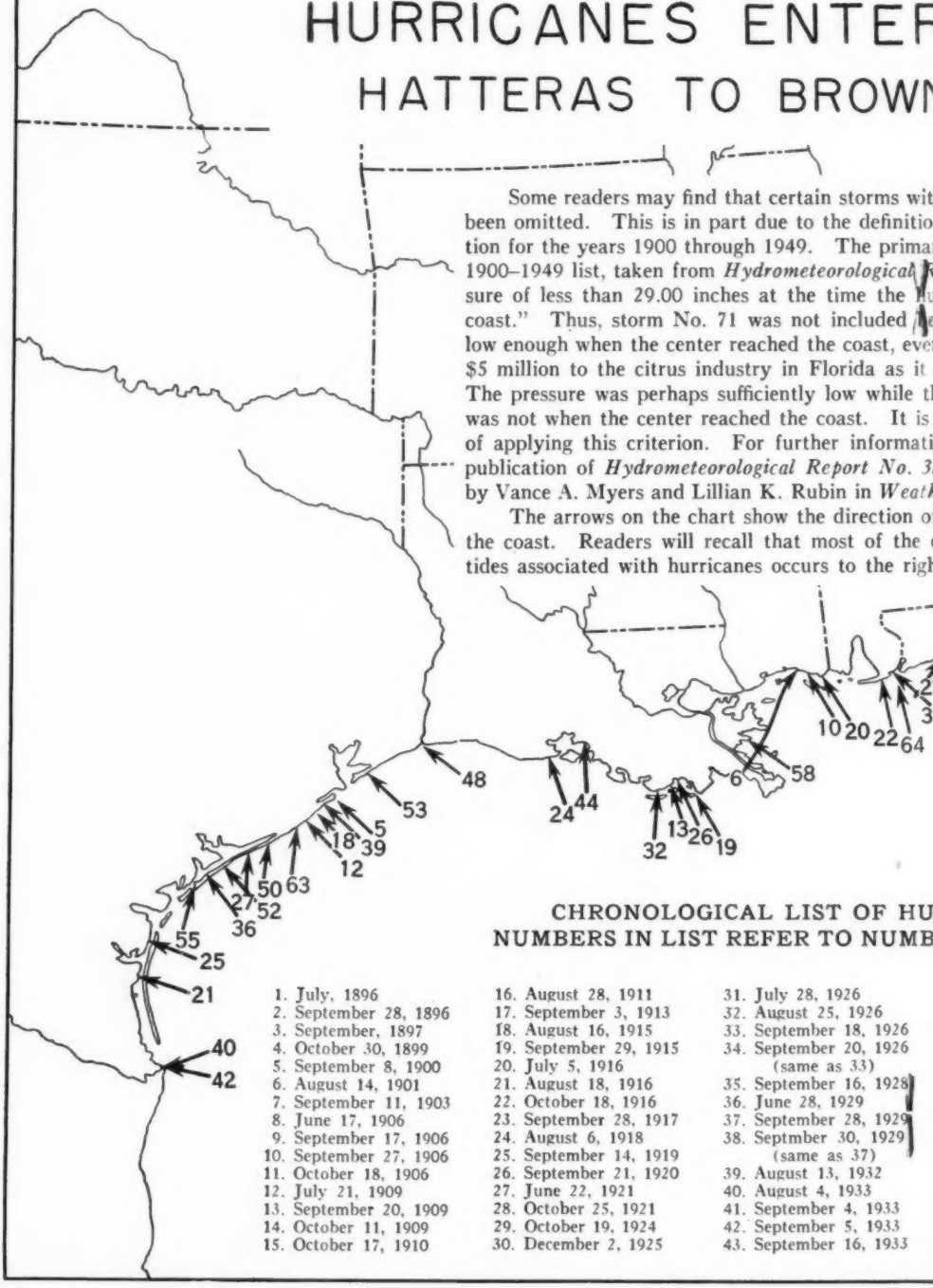
LARGE-SCALE SEEDING

Experiments were conducted by New York University meteorologists during the past two winter seasons to observe the large-scale effects on the weather from seeding typical East Coast cyclones. Their statistical analysis showed no appreciable effect on the general weather pattern, although they allowed there may be local effects. Both dry ice from planes and silver iodide ground generators were employed.

HURRICANES ENTER
HATTERAS TO BROWN

Some readers may find that certain storms wit
been omitted. This is in part due to the definitio
tion for the years 1900 through 1949. The prima
1900–1949 list, taken from *Hydrometeorological*
sure of less than 29.00 inches at the time the
coast." Thus, storm No. 71 was not included
low enough when the center reached the coast, eve
$5 million to the citrus industry in Florida as it
The pressure was perhaps sufficiently low while t
was not when the center reached the coast. It is
of applying this criterion. For further informati
publication of *Hydrometeorological Report No. 3*
by Vance A. Myers and Lillian K. Rubin in *Weat*

The arrows on the chart show the direction o
the coast. Readers will recall that most of the
tides associated with hurricanes occurs to the righ

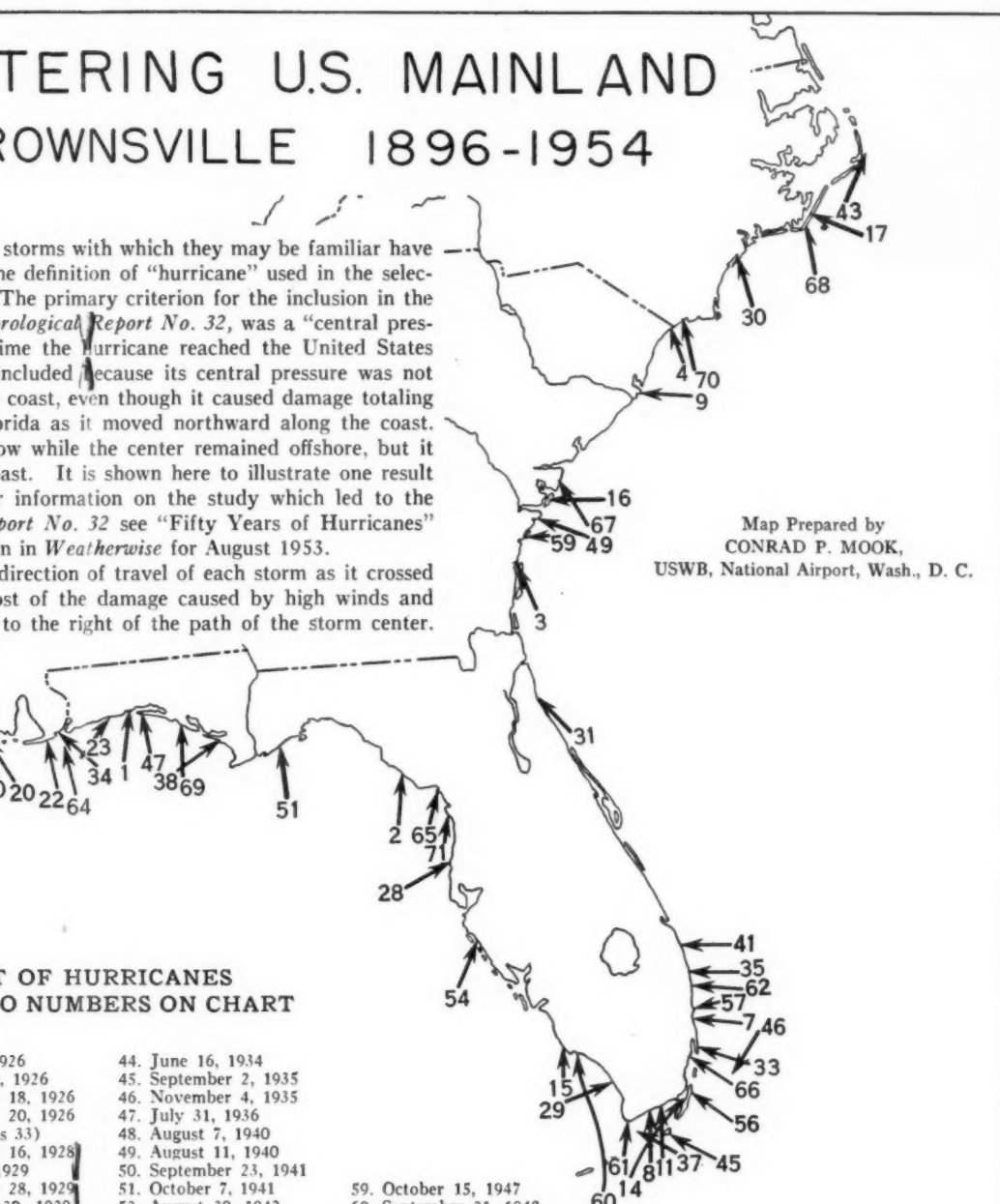


CHRONOLOGICAL LIST OF HU
NUMBERS IN LIST REFER TO NUMB

1. July, 1896
2. September 28, 1896
3. September, 1897
4. October 30, 1899
5. September 8, 1900
6. August 14, 1901
7. September 11, 1903
8. June 17, 1906
9. September 17, 1906
10. September 27, 1906
11. October 18, 1906
12. July 21, 1909
13. September 20, 1909
14. October 11, 1909
15. October 17, 1910
16. August 28, 1911
17. September 3, 1913
18. August 16, 1915
19. September 29, 1915
20. July 5, 1916
21. August 18, 1916
22. October 18, 1916
23. September 28, 1917
24. August 6, 1918
25. September 14, 1919
26. September 21, 1920
27. June 22, 1921
28. October 25, 1921
29. October 19, 1924
30. December 2, 1925
31. July 28, 1926
32. August 25, 1926
33. September 18, 1926
34. September 20, 1926 (same as 33)
35. September 16, 1928
36. June 28, 1929
37. September 28, 1929
38. Septmber 30, 1929 (same as 37)
39. August 13, 1932
40. August 4, 1933
41. September 4, 1933
42. September 5, 1933
43. September 16, 1933

TERING U.S. MAINLAND
ROWNSVILLE 1896-1954

storms with which they may be familiar have
he definition of "hurricane" used in the selec-
The primary criterion for the inclusion in the
rological Report No. 32, was a "central pres-
ime the Hurricane reached the United States
ncluded because its central pressure was not
coast, even though it caused damage totaling
rida as it moved northward along the coast.
ow while the center remained offshore, but it
ast. It is shown here to illustrate one result
information on the study which led to the
port No. 32 see "Fifty Years of Hurricanes"
n in *Weatherwise* for August 1953.
direction of travel of each storm as it crossed
st of the damage caused by high winds and
to the right of the path of the storm center.



Map Prepared by
CONRAD P. MOOK,
USWB, National Airport, Wash., D. C.

T OF HURRICANES
O NUMBERS ON CHART

926
, 1926
18, 1926
20, 1926
s 33)
16, 1928
929
28, 1929
30, 1929
s 37)
, 1932
1933
4, 1933
5, 1933
16, 1933

44. June 16, 1934
45. September 2, 1935
46. November 4, 1935
47. July 31, 1936
48. August 7, 1940
49. August 11, 1940
50. September 23, 1941
51. October 7, 1941
52. August 30, 1942
53. July 27, 1943
54. October 19, 1944
55. August 27, 1945
56. September 15, 1945
57. September 17, 1947
58. September 19, 1947
59. October 15, 1947
60. September 21, 1948
61. October 5, 1948
62. August 26, 1949
63. October 4, 1949
64. August 30, 1950
65. September 5, 1950
66. October 18, 1950
67. August 30, 1952
68. August 13, 1953
69. September 26, 1953
70. October 15, 1954
71. October 8, 1946

Recent Specialized Meteorological Books (1952–1954)

MALCOLM RIGBY, *Editor, Meteorological Abstracts*

IN the April issue of *Weatherwise*, 15 recent books covering general aspects of meteorology and earth science were reviewed in a non-critical manner for the benefit of the amateur meteorologist. Space did not permit mention of an additional 25 or 30 more specialized or technical books which would still be of interest to our readers who are often more inclined to be "specialists" (because they can afford to be), than the professional meteorologists (since the latter must often be versatile in their science in order to earn a living).

The books reviewed cover a wide field of material, and any reader should be able to find one or more books which coincide with his own special field of interest.

Song of the Sky by **Guy Murchie,** Riverside Press, Cambridge, Mass., 1954. 438 p. $3.95. This is a classical example of not mere popularization, but glorifying or romanticizing of science and nature in a manner similar to that achieved by Rachel Carson in *The Sea Around Us* and by George Stewart in *Storm*.

It thus well deserves the signal honor of being chosen as a Book of the Month Club selection during 1954. The author is an adventurer and journalist, a poet at heart, and in addition an expert aerial navigator and an instructor in navigation and meteorology. This rare combination has made possible this long, comprehensive and thoroughly scientific, yet exciting and readable text covering every conceivable aspect of navigation—especially trans-oceanic air navigation and aeronautical meteorology. In 15 separate chapters the author deals with the history of navigation from the earliest attempts to sail, down through the Middle Ages when instruments first came into use, to the present highly technical electronic and celestial methods of navigation; experiences in transatlantic cargo plane navigation during World War II, and in teaching navigation "in the field"; the ordinary and the spectacular elements of the weather such as wind, cloud, fog, dust, rain, hail, thunderstorms, tornadoes, icing, heat, cold, hurricanes, snow, the jet stream, auroras, geomagnetism, the ionosphere, mountain and topographic effects, thermals, air masses, fronts and forecasting, etc., etc.; and an equally wide array of subjects concerning navigation. But most of all, the author makes the reader feel he is sitting beside the pilot in the huge cockpit and experiencing all the sensations of anxiety and relief, of elation and boredom, that the navigator experiences during the endless hours up among the stars or "in the soup" over the vast expanses of the North Atlantic, Pacific, or Tropical Seas, and under the endlessly changing kaleidoscope of weather in a turbulent, 3-dimensional atmosphere.

Murchie's book covers the Arctic, the middle latitudes, and the Tropics, but a number of specialized books on the Tropics have appeared lately. Riehl's excellent book *Tropical Meteorology* was reviewed in the April 1955 WEATHERWISE. Two more books which concern the tropics from the point of view of the geographer or the commercial consultant are *The Tropical Rain Forest* and *Deterioration of Materials*.

The Tropical Rain Forest by **P. W. Richards,** Cambridge Univ. Press, 1952. 450 pp. illustr. $12.50, contains a large section on rainfall, temperature, humidity, climate, and microclimate of forests of the tropical regions.

Materials deteriorate very rapidly in the tropics or along sea coasts, and technical

papers on this important subject are hard to locate. A huge book **Deterioration of Materials** by **Glenn A. Greathouse and Carl J. Wessel,** Reinhold, New York, 1954. 835 pp. $12.00, contains as its first chapter of 67 pages a discussion of "Climate and Deterioration," by Carl J. Wessel and H. C. S. Thom, the latter chief climatologist of the U.S. Weather Bureau at the time of publication.

The subject of climatic change has aroused as world-wide interest as that of interplanetary travel, and like the latter has evoked a number of semi-scientific as well as technical pamphlets and books which bring home the tremendously important economic consequences of the continuing "warming of the Arctic" and melting of glaciers and Arctic pack-ice. Among these books are: **Climatic Change, Evidence, Causes and Effects** edited by Harlow Shapley, Harvard Univ. Press, 1953. 318 pp. $6.00. (Reviewed by H. C. Willett on pp. 229 and 233, May 1954 *Bulletin of the AMS.*) In this "Compendium" of articles on various aspects of climatic change in relation to physical and biological factors on earth, such well-known authorities as H. Wexler, H. C. Willett, J. H. Conover, V. Conrad, D. H. Menzel, R. F. Flint, E. Schulman and many others, discuss the astronomical, solar, radiational, glaciological, treering, geological, anthropological, vegetational, oceanographic, racial, and other evidence or consequences of climatic change.

Glacier Variations and Climatic Fluctuations by **H. W:lson Ahlmann,** American Geographical Society, N. Y., 1953. 51 pp. $3.50, goes into one narrow, but very significant aspect and evidence of climatic change in a readable manner, though written by the world's outstanding authority on the subject.

The key to the cause of climatic changes, as well as day-to-day weather vagaries, may well be found in the stratosphere or ionosphere which is being intensively explored by rockets, radio, and perhaps in a few years by guided "space ships" or artificial satellites. A few of the many interesting books on this phase of meteorology are: **High Altitude Rocket Research** by **Homer E. Newell, Jr.,** Academic Press, N. Y., 1953. 298 pp. $7.50; and **The Physics of the Stratosphere** by **R. M. Goody,** Cambridge Univ. Press, 1954. 187 pp. $5.00, one of the *Cambridge Monographs on Physics* series; and finally, **Rocket Exploration of the Upper Atmosphere** by **R. L. F. Boyd and M. J. Seaton,** Pergamon Press Ltd., London, 1954. 376 pp. 75s. (about $11.00), gives the results of articles presented at the Oxford Conference on Rocket Techniques by the Upper Atmosphere Rocket Research Panel of the U.S.A. and the Gassiot Committee of the Royal Society of London. Over 40 papers by the authorities of several countries on rocket techniques, pressure, temperature, winds, chemical composition, solar radiation, ionization, cosmic rays, and other aspects of high atmosphere physics are integrated into an elaborate, readable and well-illustrated book that gives the latest information on this most recent realm of exploration.

For those who wish to stay *close* to the earth in their exploration and observation (below 80,000 feet, say), the latest instruments, methods, and devices for observing winds, temperature, humidity, pressure, sunshine, clouds, visibility, precipitation, etc., are discussed and illustrated in the beautiful new edition of Middleton's unique text: **Meteorological Instruments** by **W. E. K. Middleton and A. F. Spilhaus,** 3rd ed. rev., Univ. of Toronto Press, 1953. 286 pp. $11.50. Automatic weather stations, airplane reconnaissance, mobile weather stations, radiosondes and rawinsondes, and many uses of radar in meteorology, ceiling and visibility meters as well as conventional instruments, are discussed in detail.

In **Vision Through the Atmosphere** by **W. E. K. Middleton,** Univ. of Toronto Press, 1952. 250 pp. $10.00, the optical, physiological, and observational aspects of visibility and measuring or estimating visual range by day or night are treated in an equally thorough and scientific, yet lucid manner.

Physical Meteorology by **John C. Johnson,** Worcester Poly Institute, Wiley, N. Y., 1954. 393 pp. $7.50, is an advanced text which gives the most detailed treatment to a few aspects of dynamic and physical meteorology: ionospheric physics, cloud physics and "rain making," radar meteorology, icing of aircraft and other objects and meteorological optics.

Micrometeorology. A Study of Physical Processes in the Lowest Layers of the Earth's Atmosphere by **O. G. Sutton** (Director of Meteorological Office, London), McGraw-Hill, N. Y., 1953. 333 pp. $8.50, gives an equally intensive treatment to problems of turbulence, diffusion, evaporation, and local heating in the few feet above the ground where we and the plants and animals live. The same author has, in the versatile manner of all true scientists, written another book entitled: **Mathematics in Action** by **O. G. Sutton.** Drawings and diagrams by A. J. Laurie, G. Bell & Sons, Ltd., London, 1954. 226 pp. Chapter 3 on "Ballistics" (pp. 68–90), and Chapter 7 on "Mathematics and Weather" (pp. 194–213), give interesting discussions of mathematical solutions of problems of atmospheric factors affecting the flight of missiles, forecasting by numerical processes, or statistical and dynamical calculations in meteorology.

A most thorough treatment of every imaginable application of statistics to climatological or meteorological problems is contained in **Handbook of Statistical Methods in Meteorology** by **C. E. P. Brooks and N. Carruthers,** Her Majesty's Stationery Office, London, 1953. 412 pp. 25s. The material was accumulated during and for a few years after the Second World War from the vast experience of the author and his statistical assistant in answering requests for climatological compilations which could be directly applied to military, naval, aviation, industrial, commercial, agricultural, marine, and host of other problems requiring some knowledge of the field of meteorology as well as the field to which the data would be applied. It is essentially a handbook or collation of samples showing methods of treating data and resulting curves or tables of data, but can also be used as a textbook since it is arranged in a logical and orderly fashion, and is well indexed for reference. Of course new applications spring up every day, and it has been several years since the copy was completed (it was delayed two or three years in publication), but it will be years before anyone equals or duplicates this book for usefulness.

Two recent books on cloud physics and thunderstorm electricity should not be overlooked. They are:

Thunderstorm Electricity by **Horace R. Byers** (ed.), Univ. of Chicago Press, 1953. 345 pp. $6.00, and **Atmospheric Electricity,** 2nd ed. by **B. F. J. Schonland,** Wiley, N. Y., 1953. 95 pp. $1.75.

Dynamical Oceanography by **Joseph Proudman,** Methuen, London, 1953. 409 pp. $8.50, is an excellent technical work on ocean waves, tides, currents, etc. and the atmospheric and other factors which control or which are affected by them.

Finally, mention should be made of the three most recent Meteorological Monographs published by the American Meteorological Society. They are: **Thirty Day Forecasting: A Review of a Ten Year Experiment** by **Jerome Namias,** American Meteorological Society, Boston, Meteorological Monographs 2(6), July 1953. 83 pp. $3.50; **The Jet Stream** by **H. Riehl, M. A. Alaka, C. L. Jordan and R. J. Renard,** American Meteorological Society, Boston, Meteorological Monographs, 2(7), Aug. 1954. 100 pp. $3.50. Foreword by Capt. F. A. Berry. A revision of the excellent NAVAER report on the jet stream and its characteristics over the U.S.A., the North Atlantic and North Pacific, especially important for high altitude aviation and for forecasting storms of all types; and lastly, **Recent Studies in Bioclimatology** edited by **F. Sargent II and R. G. Stone,** American Meteorological Society, Meteorological Monographs, 2(8), Oct. 1954. 121 pp. $5.00, containing articles on climate and crops, forests, farm animals, man, housing, disease, etc.; and effects of radiation, cosmic rays, smog, season, altitude, etc., by such well-known authorities as Thornthwaite, Mather, Sargent, Landsberg, Buettner and others.

Thus it can be seen from this small sample what a wealth of recent popular and semi-technical material is available in the English language for anyone who has access to a good library or the desire to build up his own technical library. The practical knowledge to be gained from an investment of anywhere from $20 to $100 in such "tools" would more than repay the investment in years to come—not to mention the satisfaction to be gained from aroused interest in an ever-expanding field of knowledge no matter how narrow or broad it may be.

RADAR

By the 1956 hurricane season a year hence the Atlantic Coast will have the protection of a modern storm detection and tracking radar network. At the present writing some units are in operation, others are being installed, and most of the final units will be in operation in 12 months.

At the present time modified Navy surplus units are in operation by Weather Bureau personnel at Boston, New York City, and Washington, D. C., and the summer of 1955 will see one at the vantage point of Cape Hatteras, North Carolina, the check-point for all northward-moving hurricanes. Though of limited range and capabilities, these radars are effective tracking devices for severe storms.

New sets of the CPS-9 type (designed especially for weather detection) will be installed at Nantucket, Mass., New York City, Wilmington, North Carolina, Daytona Beach and Miami, Florida, under the provisions of the 1956 Weather Bureau budget. In addition, the Air Weather Service of the U. S. Air Force, who developed the CPS-9, will expand its coverage in the hurricane area. Sets are now in operation at Blue Hill, Mass., and at Belmar, New Jersey. Other locations will be in Maryland, North Carolina, and Georgia.

The Continental Air Defense Command will also assist in the far-flung radar operations. A number of offshore platforms are to be built along the Atlantic Coast at 100 to 150 miles from shore; these will offer advantageous locations for future surface, upper-air, and radar observations. Furthermore, the CADC maintains a squadron of radar picket boats and flies special Super-Constellation picket planes. For weather detection purposes all of these will be tied into a weather filter center, and the information will be relayed to the hurricane forecast centers.

The modern eye of radar, thus, will soon fill the blank spot of no reports in the dangerous eastern semicircle of Atlantic Coast hurricanes.

H. R. 5260 DOOMED?

As this issue goes to press, the status of the "Hurricane Bill" remains uncertain. The House Appropriations Committee added $2¼ million to the Weather Bureau budget to operate a hurricane warning service. The Senate had not yet acted. It appears that H. R. 5260 may be scuttled, but that some funds will be made available for most of the 10-point program outlined on page 63.

THOSE LADIES AGAIN!

Here is the list of names selected for use in 1955 for hurricanes in the Gulf of Mexico, Caribbean Sea, and Atlantic Ocean: Alice — Brenda — Connie — Diane — Edith — Flora — Gladys — Hilda — Ione — Janet — Katie — Linda — Martha — Nelly — Orva — Peggy — Quenna — Rosa — Stella — Trudy — Ursa — Verna — Wilma — Xenia — Yvonne — Zelda. Let us hope that we do not see all of them this year!

COMMUNICATIONS

The Weather Bureau maintains a special hurricane teletypewriter circuit which connects all offices on the Gulf and South Atlantic coasts from Brownsville, Texas, to Charleston, South Carolina. All stations receive instantaneously all messages written by any other hurricane stations. In addition, the three Atlantic Coast forecast centers are tied in with all other coastal stations connected with the hurricane teletypewriter.

The forecast centers concerned with hurricanes and their districts follow:

Boston—the New England coast and waters
Washington—35 N to Long Island
New Orleans—Gulf of Mexico and Caribbean from 85 W
San Juan—Caribbean Sea and islands east of 75 W and south of 20 N
Miami—Caribbean between 75 and 85 W; the East Gulf; the Atlantic south of 35 N

During the progress of a tropical storm four advisories per day are normally issued, since the forecasts are based on observations taken every six hours. These advisories are distributed at 0500, 1100, 1700, and 2300 EST. If a hurricane is approaching land, additional advisories at intermediate periods are usually issued.

Hurricanes (*Continued from page 67*)

at Jupiter Light in the 1949 storm. The extreme gusts in these same two storms presumably must have been stronger than any others, although they were not reported.

In addition to the strength of the winds, the length of time that a place is subjected to high winds would certainly have a relation to the amount of damage caused. For some of the "great" hurricanes where this time was unusually long, the data are available. For example, in the 1926 hurricane Pensacola was subjected to winds of just over hurricane force for 20 hours, and for five hours had winds of 100 mph or above. In 1944 Dry Tortugas had gale winds (over 38 mph) for 72 hours and winds of 120 mph or above for two hours. In 1949 Cape Canaveral Light had gale winds or higher for 25 hours.

Minimum Width of Path with 50 MPH or over Winds

Storm	Diameter (reported miles)	Radius (calculated miles)
1926	160	102
1928	150	128
1929	130	N.A.
1944	250	N.A.
1947	300	113
1949	240	58

(N.A.—Not Available)

To further substantiate these data, it was reported in the 1947 storm that winds of 100 mph or over extended along the Florida east coast for a distance of 70 miles and hurricane force winds along the same area for 240 miles. In the 1944 hurricane it was reported that dangerous winds extended 200 miles east of the center and 100 miles to the west of it. The reported distances given for the earlier storms of 1926, 1928, and 1929 are minimum values and in each case were undoubtedly considerably greater.

The average maximum rainfall varied for all six hurricanes from 8.18 inches in 1949 to 11.04 inches in 1929, with an average maximum value of 9.40 inches.

Hurricane Precipitation

Storm	Amount in inches	Place
1926	8.76	Bradenton
	8.61	Pensacola
	8.00*	Miami
1928	8.68	Hastings
	8.61	Miami
	7.20	Starke
1929	11.04	Chapman Field
	10.63	Miami
	9.37	Everglades
1944	9.70	Jacksonville
	9.65	Hilliard
	8.62	Deland
1947	10.12	St. Lucie Lock
	8.72	Fort Myers
	7.36	Bonita Springs
1949	8.18	Belle Glade
	7.63	Melbourne
	7.10	Okeechobee City

* Incomplete.

Damage and Loss of Life in Florida

The extent of damage in dollars and the loss of life due to a hurricane is not really a true measure of its intensity or greatness. The same storm passing over different portions of the state could cause very different amounts of damage depending on its path. Furthermore, the earlier storms occurred when warnings were not as well distributed or heeded as they are now. This may be offset, however, in part now by the much greater amount of building and heavier population all over the state. On the other hand, the stricter building codes to provide for hurricane force winds, the dikes around Lake Okeechobee, and many other hurricane-conscious precautions have lowered the amount of death and destruction which accompany the later-day storms.

Storm	Damage		Total	Deaths
	Crops	Other		
1926	N.A.	$76,000,000 (in Miami)	$100,000,000	243
1928	N.A.		25,000,000	1,836
1929			500,000	3
1944	$50,000,000	13,000,000	63,000,000	18
1947	10,000,000	21,800,000	31,800,000	17
1949	20,000,000	25,000,000	45,000,000	2

Storm Tides

A factor sometimes more serious than the destructive winds is the storm tide accompanying a hurricane. The storm tide, of course, affects only those places near the water or which are at a low elevation and can be easily flooded. Much of the death and property damage of at least two of the "great" Florida hurricanes was due to storm tides,

namely at Miami in 1926 and at Lake Okeechobee in 1928.

Storm	Feet above mean low tide	Place
1926	11.7	Miami
	10.7	Miami Beach
1928	10–15	Lake Okeechobee
1929	N.A.	
1944	12.28	Jacksonville Beach
1947	5.5	Everglades City
1949	12	Lake Okeechobee

The tabulation shows that it is possible for these storm tides to be as much as 10 to 15 feet above the mean low tide, and with the wave action, several more feet can be added.

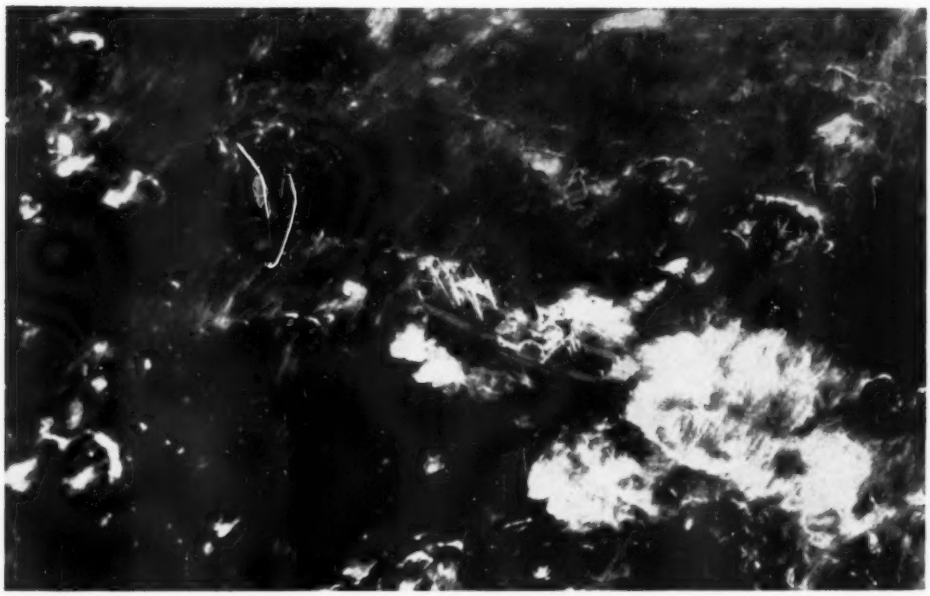
Peculiarities

The eccentricities of hurricanes have always been a wonder to man. In the category of peculiarities of our six "great" Florida hurricanes are the presence of tornadoes within the peripheries of the 1929, the 1944, and the 1947 hurricanes; the destructive gusts (probably a plow wind) of 20 to 30 seconds duration in the 1926 storm at Jupiter; the erratic paths and movements in the 1929 and the 1947 centers; and the unusual sizes of the central cores. The 1944 storm had an elongated oval-shaped core about 70 miles long with the principal axis along its line of advance, in direct contrast to the 1926 hurricane which had a central core of only 13 miles in diameter when it passed over Miami.

Summary

In making a comparison of six "great" Florida hurricanes one is always tempted to arrange them in some order of intensity based on all the available data. The Hydrometeorological Section of the U. S. Weather Bureau has undertaken an analysis of all major hurricanes of the Twentieth Century and this paper would be incomplete if it did not mention some of the data which have been published. The most interesting results are the empirical calculations of: (1) the lowest pressure, (2) the radial distance to the maximum winds, (3) the extreme gradient wind, and (4) the kinetic energy of the cyclostrophic wind in a radius of 50 miles. These data are shown in the following table.

(*Continued on page 82*)



A hurricane reconnaissance plane spots a merchant ship in the eye of Carol off the coast of Florida. United Press Photos.

Weatherwatch

Spring 1955—Hot and Cold, Wet and Dry

DAVID M. LUDLUM, *Editor*

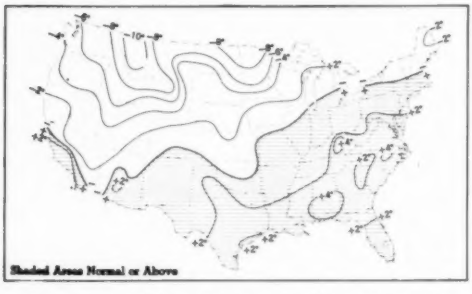
MARCH is usually the most interesting meteorological month on the calendar, and the first spring month of 1955 proved to be outstanding in the variegated display of nature's fury. At this time of the year cold season conditions still prevail across Canada and the northern tier of states, which are locked in a deep snow cover and capable of producing Arctic air masses. In the tropics and across the tier of states bordering on the Gulf of Mexico, however, the warming effect of the climbing sun has already produced summer-like air masses whose heat and moisture content possess great potential energy. When these contrasting air masses meet over the central valleys of the United States, widespread outbreaks of unusual weather always follow.

Early in March the South experienced a heat wave that continued for three full weeks almost without a break. On 2 March the mercury soared to 82° at Jackson, Mississippi, for a new early-season record. In another burst of thermal energy the temperature reached 90° at Savannah, Georgia, on the 16th. Most stations throughout the South set early season records and some reached all-time March maxima. At the same time it was extremely cold over the Northwest and the northern Plains. Spokane, Washington, reported −3° on the 4th, and it was down to −25° in North Dakota during the first week. These, however, were mild compared to the great outbreak of polar air that took place during the last decade of the month; as late as the 25th the mercury slid to −30° at Helena, Montana, for the coldest March reading there in 75 years.

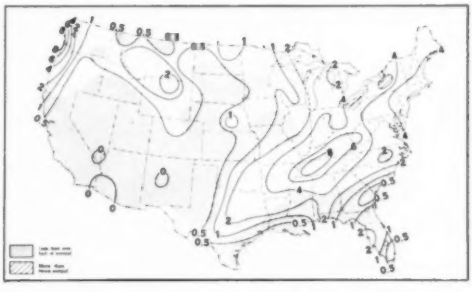
The reasons behind the great thermal contrasts over the United States in March are found in the mean pressure distribution which illustrates the general circulation pattern. The central feature of the mean maps over North America was a large cyclonic area over northern Quebec and the northeastern Canada Arctic archipelago. This was of unusually large extent and influence and most storm centers over the continent were drawn into its control. Directly south of the sub-Arctic cyclonic area lay a strong ridge of high pressure that stretched on an east-west axis over Florida and the West Indies for most of the month. A rather tight pressure gradient developed between these two forces, producing a fast flow of northwesterly winds over the western and northern part of the country and a strong southwesterly flow over the southern and eastern United States. Thus, the mean temperature regime for the month shows a cold compartment in the West and Northwest, but east of a line from Arizona to southern Michigan, under the influence of southwesterly flow, temperatures averaged well above normal for one of most advanced springs in history. There were, however, some remarkable reverses in the temperature pattern, as we shall see.

The mean monthly map at the near 20,000 ft. level shows pressure to be much above normal in the eastern Pacific where a ridge extended southward from the Gulf of Alaska to reinforce the northwesterly flow into the United States. The main trough downstream from the Pacific ridge was far to the east over the Atlantic Ocean southeast of Newfoundland; but there was a secondary trough of rather small depth from Lake Erie southwestward to Oklahoma, and it was along this line of mean pressure minima that the nation was divided into two general thermal compartments for most of the month. Further downstream a large blocking high appeared to the west of the British Isles and filled the area usually dominated by extensions of the Icelandic low.

MONTH OF MARCH 1955



Departure of Mean Temperature from Normal in degrees F. USWB chart.



Total Precipitation in inches. USWB chart.

Precipitation was heavy along the northern border states where the paths of travelling lows brought periodic rainfall and also from the central Mississippi Valley northeastward to New England in the moist southwesterly flow around the Arctic low. Rainfall was very deficient along the Gulf Coast under the influence of ridge conditions and drought developed there as the month progressed. It was the driest March on record at New Orleans.

Among the spectacular events of the month was the development and very rapid movement of a squall line eastward from the Plains on the 10–11th. With a low centered over northwestern Wisconsin at 1330 on the 10th, an instability line developed over Nebraska along the frontal area. The squall line moved rapidly eastward in advance of the main front, passing Toledo about 0130 on the 11th, Pittsburgh about 0800, and reaching the Atlantic Coast at New York City about 1100. Very severe wind storms swept the area from Indiana to central Pennsylvania with several tornadoes and numerous line squalls reported. Damage exceeded $1 million each in Indiana, Ohio, and Pennsylvania. A large ore crane was demolished near Pittsburgh for a major casualty. Insurance adjusters were put on emergency duty at Pittsburgh, just as in a hurricane, to handle the flood of wind insurance claims. An inspection of the surface map for the morning of the 11th shows very cold air with below zero readings over western Ontario and very warm air with 70° midnight readings over the Ohio Valley. These are the ingredients of intense instability.

The three-week warm spell in the South, unfortunately, set the stage for the most severe March freeze in 60 years. Vegetation had reached stages of development usual in mid-April under constant daytime temperatures in the 70s and 80s with fruit trees in full bloom and early crops well above the ground as March entered its last week.

A reservoir of cold air had occupied the Mackenzie basin of western Canada most of the month. On the 22nd a great anticyclone began to spread southward, and pressure reached 30.80 inches on the 23rd as a complicated frontal system sprawled across the Great Lakes and northern Plains. A push finally developed behind the Arctic air mass, and it rushed southeastward into a trough of low pressure that was crossing the Southeast.

Temperatures fell to zero as far south as Omaha, Nebraska, on the morning of the 26th. The push of cold air definitely put a spectacular end to the heat wave. As the cold front passed Shreveport, Louisiana, the mercury plunged from a maximum of 79° on the 25th to 32° at 0130 of the 26th. At Jacksonville, Florida on the 26th the fall was from 86° at 1300 to 33° at 0600 on the 27th.

The weather map early on the 26th showed an enormous ridge of high pressure crested over Montana with the barometer above 30.80 inches. The ridge extended from the Arctic to the Gulf, and this permitted a continued flow of northwesterly winds into the South for a full week. Freezing temperatures were experienced along the Gulf of Mexico coast from northwest Florida to northeastern Texas on the morning of the 27th. Mobile, Alabama, reported 26° for a new late-season low.

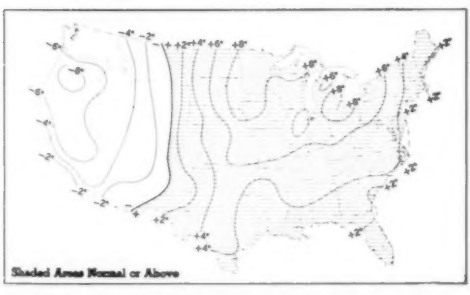
In the state of Georgia, alone, the crop losses from the March freeze were estimated at $50 million. The peach crop was the chief sufferer with all other fruits damaged. The tung nut crop and pecans were 100% destroyed, and most other tender vegetables were major casualties.

The March freeze of 1955 was the most destructive in the Southeast since that of 1894. The pressure pattern of that period was quite similar, with a great high of 30.80 inches appearing over Saskatchewan on 26 March 1894. Freezing temperatures penetrated to the Gulf coast and did major damage even to the citrus crop. At Mobile temperatures for the week 25–31 March 1894 averaged 18 degrees below normal. Going further back, similar freezes took place in 1868 and in 1854, the latter probably being the most severe of all.

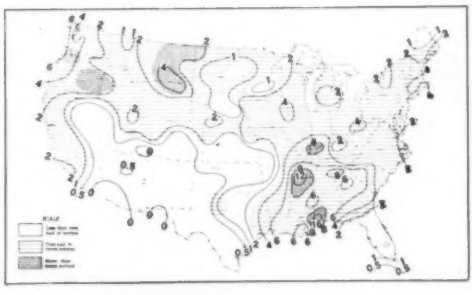
The pressure pattern and the general circulation showed considerable change during the last days of March and underwent further transformation in the first week of April. The deep upper-air trough which had permitted the flow of Arctic air into the South passed eastward, and the elements returned to a more normal set-up. For the first two weeks of the month low pressure persisted over the southern Rocky Mountain area with a result that southwesterly flow reached northeastward into southern Canada and caused a welcome early-season mild period over the eastern Plains and the Mississippi Valley.

The mean pressure map for the month showed a return of the lows to a more normal position. Minor departures from normal were noted in the Gulf of Alaska where an unusual ridge had existed in March and also east of Newfoundland in the Atlantic. The blocking ridge in the eastern Atlantic moved eastward to a position over the British

MONTH OF APRIL 1955



Departure of Mean Temperature from Normal in degrees F. USWB chart.



Total Precipitation in inches. USWB chart.

Isles and Spain. The main weather activity of the month lay in the Pacific Ocean where a tight pressure gradient, such as had prevailed over the United States in March, dominated air flow across the Pacific. Very fast westerlies brought air from the cool ocean waters into the Western states with the result that all of the country west of the 110° meridian had much below normal temperature readings.

Over the United States there was a rather flat pressure distribution on the mean maps with a weak ridge apparent over the eastern United States from the Lakes to Florida. In general, the air flow was from west-southwest to east-northeast to transport much warm air northward to all areas east of the Rockies. The outstanding feature of the month was the pleasant weather in the great farm belt, and agricultural work went ahead under very favorable spring conditions. This did not apply to the Dust Bowl area, however, for the spring breezes that brought balmy weather to the central and northern Plains caused severe dust storms in the still drought-stricken Southwest throughout the month.

The developing drought situation further east along the middle Gulf coast was definitely broken early in the second decade. Heavy rains fell in the Tennessee Valley on several occasions early in April, but amounts were light southward as the coast was approached, and fears were expressed for the new cotton crop. A cold front with a closed circulation aloft, however, moved eastward from Texas on the 11–13th and pumped enormous quantities of moisture northward. Mobile, Alabama, reported 13.36 inches on the 13th, most falling in a 6-hour period in the morning. The drought throughout the Deep South was definitely broken, but reports of flooding and much soil erosion now filled the news. Cotton planting made good progress once the fields had dried out.

Rainfall continued light over the Dust Bowl area, and several wind storms raised dust to heights of 20,000 feet and brought a pall of brown over the lower Mississippi Valley area. But just as farmers were despairing of raising a crop in northwest Texas and western Oklahoma, the rains came. There were light falls in early May and cloudbursts in the second decade.

At the end of April the deficiency in precipitation over the fall and winter of 1954–55 still held all of the great central valley of the country, with the exception of the Tennessee and parts of the Ohio valleys, in its grip. And the dry conditions extended across most of the Deep South and northeast to the North Carolina coast. In all of the Dust Bowl area rainfall was less than 50% of normal, and this applied to southwestern Texas also. In southeastern Colorado only 2 inches of moisture had fallen since August 1954. The long continued drought in the country represents the major meteorological catastrophe of the mid-century.

H. R. 5260 (*Continued from page 63*)

panying the approach and passage of hurricanes and major storms; and afterwards to survey and review (a) the quantity and quality of hurricane reports, alerts, and forecasts, (b) the times, places and amounts of hurricane information distributed by all news media, (c) the protective action taken by all concerned, (d) and the types and amounts of hurricane damage incurred.

9. To re-establish the ocean weather ship station formerly located halfway between New York and Bermuda, and maintained there by the U. S. Coast Guard for 12 years prior to its removal in June 1954.

10. To carry out a cooperative private and governmental Public Information Program involving important aspects of hurricane alerts, hurricane warnings, the changing characteristics of moving hurricanes, and the precautions that should be taken by citizens in the forecast path of future hurricanes to save lives and property.

Hurricanes (*Continued from page 79*)

Calculated Data by Hydrometeorological Section

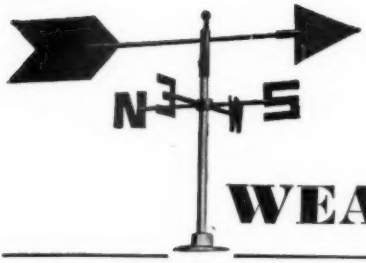
Storm	Reported lowest pressure, inches	Calculated pressure, inches	Radius to max. wind, miles	Extreme gradient wind, mph	Kinetic energy, $\times 10^{18}$ ergs/cm
1926	27.61	27.59	28	110	3.41
1928	27.62	27.62	32	117	3.46
1929	28.18	28.15	32	98	2.82
1944	28.02	28.02	31	93	2.58
1947	27.97	27.76	22	102	2.94
1949	28.17	28.16	25	99	2.85

On the basis of these and the other factors which have already been stated above, the six "great" Florida hurricanes in order of decreasing intensity could be listed:

Six "Great" Florida Hurricanes in Order of Intensity

Order	Storm
1	Palm Beach Hurricane of 1928
2	Miami Hurricane of 1926
3	Fort Lauderdale Hurricane of 1947
4	Long Key Hurricane of 1929
5	Delray Beach Hurricane of 1949
6	Dry Tortugas Hurricane of 1944

From all evidence the Palm Beach hurricane of 1928 could perhaps be listed as one of the greatest, if not the greatest, hurricane in known history to cross over Florida, with the Miami hurricane a very close second.



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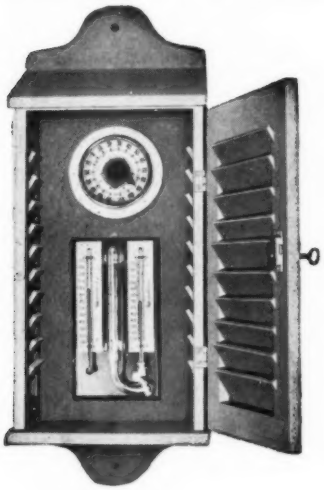

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